

found will ever be forthcoming, for, as we have already observed, we know from Miss Fawcett's wide series of skull correlations that we have practically chosen the organs of the highest correlation. Better data for determining the equations will undoubtedly be available as further craniological measurements are made, or as the great mass already made are quantitatively reduced.

In the last place we turn to the third problem: the reconstruction of the capacity of the living head. The memoir contains tables of the skull capacity of some sixty men, and also of some thirty women, whose relative intellectual ability can be more or less roughly appreciated. It would be impossible to assert any marked degree of correlation between the skull capacities of these individuals and the current appreciation of their intellectual capacities. One of the most distinguished of Continental anthropologists has less skull capacity than 50 per cent. of the women students of Bedford College; one of our leading English anatomists than 25 per cent. of the same students. There will, of course, be errors in our *probable* determinations, but different methods of appreciation lead to sensibly like results, and although we are dealing with skull *capacity*, and not brain weight, there is, we hold, in our data material enough to cause those to pause who associate relative brain weight either in the individual or the sex with relative intellectual power. The correlation, if it exists, can hardly be large, and the true source of intellectual ability will, we are convinced, have to be sought elsewhere, in the complexity of the convolutions, in the variety and efficiency of the commissures, rather than in mere size or weight.

"Total Eclipse of the Sun, May 28, 1900. Preliminary Account of the Observations made by the Solar Physics Observatory Eclipse Expedition and the Officers and Men of H.M.S. 'Theseus,' at Santa Pola." By Sir NORMAN LOCKYER, K.C.B., F.R.S. Received June 22, 1900.—Read at Joint Meeting of the Royal and Royal Astronomical Societies, June 28, 1900.

The observing station selected for my party was determined upon from information supplied by the Hydrographer, Rear-Admiral Sir W. J. L. Wharton, R.N., K.C.B., F.R.S. Santa Pola appeared likely to meet the requirements of a man-of-war, and without such assistance as a man-of-war can render, the manipulation of long focus prismatic cameras in eclipse observations in a strange country is impracticable.

Santa Pola lies very near the central line of the eclipse, and good anchorage was available, protected from some winds.



Before leaving England, I communicated with Professor Francisco Iñiguez é Iñiguez, Director of the Madrid Observatory, and Mr. Jasper Cumming, H.M. Vice-Consul at Alicante. These gentlemen, together with Don José Bonmati Mas, a large landed proprietor, and father of the Mayor of Santa Pola, very kindly made all the necessary preliminary arrangements with the local authorities, who had also been instructed by the Spanish Government, after representations had been made by the Foreign Office, at the request of the Royal Society.

As a result of the Royal Society's application to the Admiralty, H.M.S. "Theseus," commanded by Captain V. A. Tisdall, R.N., was told off to meet the expedition at Gibraltar, and convey the observers to Santa Pola.

The expedition consisted at first of Dr. W. J. S. Lockyer, from the Solar Physics Observatory, Mr. A. Fowler, the demonstrator in Astronomical Physics, from the Royal College of Science, and Mr. Howard Payn, who joined as a volunteer; I subsequently received orders to accompany and take charge of it.

Mr. Payn went on in advance overland to make preliminary arrangements and to lay out the camp on a plan which had been previously arranged, while the remaining observers left England on May 11, by the R.M.S. "Oruba," of the Orient line.

On arriving at Gibraltar, the party at once went on board H.M.S. "Theseus," and left for Santa Pola, which was reached just before noon the following day, May 17. I was glad to find that great interest had been shown in the expedition before our arrival on board, and that lectures on the work to be undertaken had already been given by the Chaplain, the Rev. G. Brooke-Robinson, M.A.

Assistants were at once forthcoming for working the prismatic cameras, and also for manipulating several cameras which I had brought out to be used by the ship's company in obtaining photographs of the corona.

Observing parties in charge of officers of the ship, to make observations along several lines, were at the same time organised.

On our arrival at Santa Pola, the following local officials came on board with Mr. Payn:—Sns. Francisco Bonmati Mas, Mayor of Santa Pola; Antoine Bonmati Mas, Vice-Mayor of Santa Pola; José Bonmati Mas, Municipal Councillor; José Salinas Perez, Municipal Councillor; Eladio Ponce de Leon, Secretary to the Mayor; Michel Sempere, Justice of the Peace; José Hernandez, Captain of the Port; Geronimo Agnati, Administrator of Customs; Eduard Fernandez, 1st Lieut. of Coast Guards; Tomas Bueno, Medical Officer.

They informed us that permission had been given for landing parties from the man-of-war, and special facilities granted for landing instruments and personal baggage without Custom's examination.

The erection of the instruments, huts, and tents was commenced on

the following morning, May 18, and by the evening of May 21 the principal instruments were reported in approximate adjustment. Drills were begun on May 22, and were carried on several times a day up to the day of the eclipse. In this work the eclipse clock, which I have described in previous eclipse reports, was used.

By permission of the Captain, three of the officers of the "Theseus," Lieuts. Andrews, Doughty, and Patrick, R.N., occupied quarters on shore to superintend the work of the parties in the camp. On board, the Chaplain gave instructions in sketching coronas and recording stars, using for this purpose a lantern which had been placed at the disposal of the expedition by the Orient Steam Navigation Company.

The weather was very favourable for the work of the expedition, but at times the landing and embarking of parties from the ship was rendered difficult by strong sea breezes and the consequent surf.

Both day and night the instruments were carefully guarded by a detachment of "Guardias Civiles," told off for the purpose by the Spanish authorities.

The groups of observers were as follows:—

LIST OF ECLIPSE PARTIES.

Timekeepers.

Lieut. F. A. Andrews, R.N.	J. Wale, 2nd Yeoman Signals.
Mr. Boughey, Mid.	W. Webb, P.O. 1.
Mr. Lambert, Mid.	Bugler Sneller, O.S.

6-inch Prismatic Camera.

Dr. Lockyer.	C. Willmott, O.S.
S. Birley, E.R.A.	A. Humphries, O.S.
J. Green, A.B.	G. Hyatt, O.S.
C. Fishenden, O.S.	

20-foot Prismatic Camera.

Mr. Fowler.	A. Maskell, A.B.
W. F. Cox, Armr.	E. Davies, O.S.
A. Whitbourne, A.B.	H. Christopher, O.S.
F. Burt, A.B.	W. Harrison, Sto. Mech.

4-inch Equatorial.

Sir Norman Lockyer, K.C.B.	C. C. Lambert, Mid.
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3½-inch Equatorial.

Lieut. H. M. Doughty, R.N.	A. G. N. Lane, Mid.
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Long-focus Coronagraph.

Mr. Payn.	H. Eary, A.B.
T. McGowan, A.B.	W. Mann, O.S.
E. Woodland, A.B.	H. Brooks, O.S.

Graham Coronagraph.

Mr. W. J. S. Perkins, Asst. Engr., R.N. J. Knowles, Chief Stoker.
W. Walker, Lg. Stoker.

De La Rue Coronagraph.

Mr. H. W. Portch, Asst. Engr., R.N. H. Frost, Chief Stoker.
W. Waterfield, E.R.A.

Dallmeyer Coronagraph.

Surgeon J. Martin, R.N. **R. Quint, Chief Stoker.**
E. Buckingham, E.R.A.

Discs.

Mr. J. B. Bateman, Mid. R.N.	}	Mr. J. A. Daniels, Torp. Gunner, R.N.
W. Fraser, Arm. Crew.		G. Fair, Armourer.
R. S. Bradbrooke, A.B.		E. Gordon, S. Carp.
H. W. Richardson, P.O. 2.	}	W. Tucker, A.B.
E. Voyle, Lg. Shipwt.		W. Brewer, A.B.
T. Orange, Boy, 1 c.		B. Salmon, Boy, 1 c.
A. Mason, A.B.	}	A. May, A.B.
A. Steven, A.B.		H. Bailey, A.B.
C. Paul, Boy, 1 c.		J. Entwistle, S. Std. Boy.

Sketches of Corona without Discs (on shore).

W. Butt, M.A.A. **H. Meacher, Pte. R.M.L.I.**
G. Guillaume, A.B. **H. Schmidtel, O.S.**

Sketches of Corona without Discs (on board).

W. Baxter, A.B. **J. Wheeler, Pte. R.M.L.I.**
W. Butts, Pte. R.M.L.I. **E. Willis, S.B. Attendant.**
C. Jacob, Pte. R.M.L.I.

Observations on Stars (on shore).

Mr. Bennett, Clerk.	H. Angus, O.S.
W. Riches, L. Seaman.	W. Kinnett, Pte. R.M.L.I.
A. Pontifex, A.B.	W. Oliver, Pte. R.M.L.I.
W. Bosworth, A.B.	

Observations on Stars (on board).

Rev. G. B. Robinson, M.A.
H. Croxon, S. Corp.
A. Phillips, Leading Shipwt.
R. Vigus, Corp. R.M.L.I.
E. Price, Pte. R.M.L.I.

E. Hammond, Sto.
G. Andrews, Sto.
G. Nightingale, Sto.
S. Wilson, Sto.
E. Savage, Pte. R.M.L.I.

Observations of Shadow Bands (on shore).

Commander Hon. R. F. Boyle, R.N. **Mr. J. G. Walsh, Mid. R.N.**
Mr. T. Slator, Naval Instructor, R.N. **Mr. F. C. Skinner, Mid. R.N.**

Meteorological Observations (on shore).

Lieut. Pattrick, R.N. Mr. G. S. Hallowes, Mid. R.N.

Meteorological Observations (on board).

G. Donnelly, Yeom. Sig.	W. Hearne, Sig.
E. Gant, Lg. Sig.	J. Beach, Sig.
A. Enstidge, Sig.	

Landscape Colours (on shore).

Capt. F. V. Whitmarsh, R.M.L.I.	Lance-Corpl. Wade, R.M.L.I.
Ship's Steward D. Green.	W. Birkett, Writer.

Landscape Colours (on board).

Fleet Paymaster A. W. Askham, R.N.	Lieut. W. J. Frazer, R.N.
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Shadow Phenomena (on shore).

Mr. C. Prynne, Carpr. R.N.

Shadow Phenomena (on board).

Lieut. H. R. Shipster, R.N.

Photographers.

J. Knight, S.B. Steward.	B. Bulbrook, A.B.
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Aide-de-Camp to Sir Norman Lockyer, K.C.B., F.R.S.

Mr. C. C. Lambert, Mid. R.N.

Time Arrangements.

According to the Admiralty chart, the latitude and longitude of the place of observation are $38^{\circ} 11' 20''$ N. and $0^{\circ} 33\cdot66'$ W. respectively. For this point, the times and position angles of contact derived from the formulæ given in the 'Nautical Almanac Circular,' No. 17, were as follows:—

Beginning of totality, May, 28 d. 4 h. 12 m.,	51·7 s.
End " " "	4 h. 14 m., 10·5 s.
Duration of totality	1 m., 18·8 s.
Position angle of first contact, $87^{\circ} 3\cdot5'$ from N. towards W.	
" " last " $93^{\circ} 47\cdot3'$ " " E.	

The experience of the Indian eclipse of 1898 suggested that the duration of totality was too long, and for the practical working during the eclipse the adopted time was 75 seconds, so that there would be no chance of spoiling the coronagraph plates by exposing them after totality. The face of the eclipse clock was graduated accordingly.

The arrangements for securing signals at definite intervals before totality was identical with that employed in Lapland and India. An image of the sun projected by the finder of the 6-inch two-prism prismatic camera was viewed on an adjustable screen, marked in such a way that it was easy to see when the cusps subtended angles of 90°

and 55° , which occurred respectively at 16 secs. and 5 secs. before totality. The signals "Go" at the commencement of totality, and "Over" at the end, were given by myself, from observations made with the 4-inch Cooke telescope.

Results.

Some of the photographs have not yet been developed, and the reports have not yet been received from the ship's parties, so that only a very brief reference to the work accomplished is possible.

The Prismatic Cameras.

The discussion of the series of photographs taken with the prismatic cameras employed in the last three eclipses indicated that continued work with this form of spectroscope should be undertaken, (1) with the view of obtaining data strictly comparable with the previous photographs, and (2) that an effort should be made to extend the inquiry into comparative lengths of the various arcs. For the first purpose it seemed desirable to repeat the Indian work with the 6-inch camera having two prisms, while for the second an instrument of longer focus was necessary.

Representations as to the importance of the latter instrument were made to the Royal Society, and ultimately the purchase of a Taylor triple lens of 6 inches aperture and 20 feet focal length was authorised. This was received so shortly before the expedition left England, that it was only possible to make a rough trial of the instrument before it was set up at Santa Pola. Both prismatic cameras were worked in conjunction with siderostats, calculations having shown that the position angles of contact were favourably situated after reflection.

Dr. Lockyer took charge of the two-prism instrument, and Mr. Fowler of that having a long focus, and in each case the programme of exposures was successfully performed.

The photographs which have been developed indicate the same succession of phenomena recorded in the three previous eclipses, but the recent eclipse was specially advantageous, for the reason that the chromospheric arcs at the instant of contact were of greater length.

A very complete record of the spectrum of the chromosphere at various depths has been secured with both instruments, and it seems probable that new information as to the distribution of the various vapours will be furnished by the photographs taken with the long-focus instrument.

The spectrum of the corona shows the green ring at $5303\cdot7$, the blue ring at 4231 , and the violet ring at $3987\cdot0$: others may possibly appear on closer examination. All the rings are of totally different character from the chromospheric arcs, and have their greatest bright-

ness in regions other than those where the chromospheric arcs are brightest. As before, 3987·0 is much more uniform in brightness throughout the extent of the ring than the others; 5303·7 is especially strong in one or two regions; but on the whole is probably weaker than in 1898.

The photographs show that the scale of the spectra is by no means too large for work with short exposures with a lens of 6 inches aperture. The spectra are 7·5 inches long from D₃ to K, and the diameter of the rings is 2·5 inches; photographs taken with an exposure estimated at $\frac{1}{4}$ of a second are fully exposed.

The Differences between the Coronas observed at the Periods of Sun-spot Maxima and Minima.

My attention was called especially to these differences, because I saw the minimum eclipse of 1878, while the phenomena of that of 1871 (maximum) were still quite fresh in my mind. My then published statements have been amply confirmed during the eclipses which have happened since 1878, but certainly the strongest confirmation has been obtained during the present one, which took place two more spot periods after 1878.

1. Form.

With regard to form, at the instant of totality I saw the 1878 corona over again, the wind vane appearance being as then most striking.

2. The Spectrum.

In connection with the eclipse of 1878 (minimum), I pointed out that, whereas in 1871 (maximum) the spectrum of the corona viewed by small dispersion was remarkable for the brightness of the lines; in 1878 they were practically absent, and the continuous spectrum was remarkably brilliant.

I determined therefore to make a similar observation in this year of maximum, and, as in 1878, used a grating first order spectrum placed near the eye. The result was identical with that recorded in 1878. I saw no obvious rings or arcs, but chiefly a bright continuous spectrum.

3. The Minute Structure of the Inner Corona.

Lieut. Doughty, R.N., and myself made observations on the minute structure of the corona, in order to see if any small details could be observed, and whether they were the same as those I saw so well and recorded during the eclipse of 1871, at a period of sun-spot maximum. This question was specially taken up this year, as exactly two sun-spot periods have elapsed since 1878.

In 1871 I used a 6-inch object glass, and distinctly observed marked delicate thread-like filaments, reminding one of the structure of the prominences, with mottling and nebulous indications here and there; some of these distinct markings were obvious enough to be seen till some minutes after totality.*

This year, with a perfect 4-inch Taylor lens and a high power, not the slightest appearance of this structure was to be traced; the corona some 2' or 3' above the chromosphere was absolutely without any detailed markings whatever.

Lieut. Doughty duplicated and confirmed these observations with a $3\frac{3}{4}$ Cooke. Here, then, is established another well-marked difference between maximum and minimum coronas.

The Coronagraphs.

Four coronagraphs were employed of various apertures and focal lengths. One, of 4 inches aperture and 16 feet focal length, was in charge of Mr. Howard Payn, while the others were controlled by officers of the ship.

The results obtained are very satisfactory, those taken with the long-focus instrument being especially good. In this case the image is $1\frac{3}{4}$ inches in diameter, and the definition is perfect. The photograph taken with an exposure of 5 seconds shows a great wealth of detail in the inner corona and prominences; the fine definition appears to be due to the fact that a Taylor photo-visual lens was employed, bringing the rays of various refrangibilities to the same focus. A long exposure photograph, with the same instrument, is remarkable for the perfect hardness of the moon's edge, notwithstanding the motion during totality.

The three photographs secured by Asst. Engineer Portch, R.N., with the De la Rue lens of $4\frac{5}{8}$ inches aperture, give also sharp images with much fine detail.

Sandell triple-coated plates were used with this instrument.

With the 6-inch Dallmeyer lens, two photographs on Sandell plates were obtained by Dr. Martin, R.N., one being exposed for about half a second, and another for 50 seconds.

The longer exposure records the extensions to a greater distance from the dark moon than any of the other photographs obtained, with the exception of the one secured with the small-grating camera.

This last-mentioned instrument consisted of a Zeiss anastigmatic lens of 9 inches focal length, with a small Thorp grating mounted in front of it. The exposure of the plate was 40 seconds during totality; the longest streamer in the N.E. quadrant extends to a distance of $4\frac{1}{2}$ lunar diameters.

* 'Solar Physics,' p. 372.

Discs.

Six discs for cutting out the bright light of the inner corona were erected, with the view of enabling the observers to detect the long extensions if there should be any. They were very carefully set up by Lieuts. Doughty and Andrews, R.N., and were provided with eye-pieces having all necessary adjustments. Mr. Daniels, torpedo gunner, then took charge of the party, and numerous rehearsals were given. In the trials remarkable skill in recording delicate details was displayed.

During the eclipse, the actual observer was blindfolded for five minutes before totality.

No extensions of the nature observed by Professor Newcomb in 1878 were recorded.

Observations on the Stars Visible during Totality.

A large party for the observation of stars visible during totality was trained and organised by the Chaplain, Rev. G. Brooke-Robinson, R.N., who was provided with a set of star charts for purposes of instruction prior to the eclipse, and another set, prepared by Dr. Lockyer, for making records during the eclipse.

Venus became visible at a very early stage of the eclipse, and during totality Mercury was a very conspicuous object near the extremity of one of the streamers. α Tauri, α and γ Orionis were also recorded. No comet or unknown body was noted.

Shadow Bands.

The Naval Instructor on H.M.S. "Theseus," Mr. T. Slator, B.A., undertook this branch of the eclipse work, and during the eclipse worked in conjunction with the Commander, the Hon. R. F. Boyle. Very complete arrangements were made for securing the orientation of the bands (1) on a horizontal plane; (2) on a plane in the meridian; (3) on a plane in the prime vertical. The bands appear to have been very ill-defined, but the necessary observations were secured in planes 1 and 2.

Meteorological Observations.

A regular series of observations of temperature and pressure was established three days before the eclipse, and continued until two days after; Lieut. Patrick, R.N., taking charge of this branch of the work. During the eclipse the temperature fell 5° C., and the barometer also fell slightly.

The thanks of the expedition are due especially to those named in

the foregoing account, not only for assistance rendered, but also for their great kindness to us. I have already, in a letter, expressed to the Royal Society my deep sense of the obligation they have laid us under.

As in the case of the "Volage" and "Melpomene," the officers and men of the "Theseus" not only assisted us with certain instruments, but organised crews for others, and many lines of work which it was impossible for the observers sent out from England to attempt. Their skill, resourcefulness, and steadiness were alike truly admirable.

Thanks are also due to the Managers of the Orient Steam Navigation Company, who conveyed the instruments to and from Gibraltar freight free.

I may add, the Civil Governor of the Province of Alicante, Señor don Hipoldo Caras y Gomez de Andino, visited the camp to assure himself that all the assistance the Spanish authorities could give had been rendered.

"Total Solar Eclipse of 1900 (May 28). Preliminary Report on the Observations made at Bouzareah (in the Grounds of the Algiers Observatory)." By Professor H. H. TURNER, M.A., F.R.S., and H. F. NEWALL, M.A., Sec. R.A.S. Received June 28,—Read at Joint Meeting of the Royal and Royal Astronomical Societies, June 28, 1900.

The Report is presented in three parts.

PART I. ORIGIN OF THE EXPEDITION AND GENERAL PREPARATIONS BY THE TWO OBSERVERS JOINTLY (§§ 1—10).

PART II. SEPARATE REPORT BY PROFESSOR TURNER.

§§ 11—12. The Cameras and Cœlostat.

§ 13. The Polariscopes.

§§ 14—16. Adjustments.

§§ 17—19. Programme of Observations.

§§ 20. The Standard Squares.

§ 21. Use of Green Screen.

§ 22. Integral Photometer.

§ 23. Development.

PART III. SEPARATE REPORT BY MR. NEWALL.

§ 24. The Four-prism Spectroscope with Slit.

§ 25. The Photographic Camera with large Objective Grating.

§ 26. The Polaroscopic Camera (Savart Plates and Nicol Prism).

§ 27. Atmospheric Polarisation.

§ 28. General Observations.